Appendix I

PINEDALE ANTICLINE EMISSIONS SOURCES

CENTRALIZED FACILITIES MITIGATION MEASURE

I.0 Emissions from PAP Sources - Centralized Facilities Mitigation Measure

A mitigation measure proposed for the Pinedale Anticline Project (PAP) involves operating centralized facilities on a percentage of the 700 proposed wells. Under this scenario, processing equipment is located at a centralized facility (CF) for a group of wells instead of at each individual well site. Two configurations are being considered: one CF per 16 wells (1/16 configuration) and one CF per 8 wells (1/8 configuration). Both configurations of this mitigation measure result in production emissions that differ from the original production emissions presented in Section 2.0 of the Air Emissions Inventory Technical Report, May 1999. The required operational modifications, as well as the resulting production emissions, associated with the 1/16 configuration are presented in Sections I.1 and I.2, respectively. The emissions associated with the 1/8 configuration are discussed qualitatively in Section I.3.

For economic reasons, it is also possible for only a portion of the proposed wells to be operated using centralized facilities. Therefore, production emissions are presented for several scenarios (i.e., 0%, 25%, 50%, 75%, and 100% of the wells operated by centralized facilities). Note that the 0% centralized facilities scenario is equivalent to the original scenario presented in May 1999 emissions report. This mitigation measure does not affect PAP well construction emissions or the emissions from and locations of other NEPA projects, WOGCC wells, and permit actions within the study boundary.

I.1 Operational Modifications for the 1/16 Centralized Facilities Configuration

The primary mitigation measure being considered for the Pinedale Anticline Project consists of centralized facilities that control 16 wells each (1/16 configuration). When centralized facilities are introduced into the Pinedale Anticline Project, the production emissions change in a couple of fundamental ways. These differences are described below.

- The glycol dehydration unit is moved from the well site to the centralized facility.

Combustion emissions from the glycol heaters will be lower for the CF mitigation measure than in the original analysis. The glycol heaters at each well (0.125 MMBtu/hour, each) are replaced with one larger heater (0.25 MMBtu/hour) at the centralized facility. The total fuel combustion for the sixteen wells decreases under the CF mitigation measure, thereby resulting in lower overall combustion emissions.

VOC and HAPs emissions from glycol dehydration will also be lower under the CFs mitigation measure than for the original scenario. Because the glycol dehydration units at the individual

well sites emitted small quantities of VOCs and HAPs, no controls were required. However, the larger glycol dehydration units will trigger the Wyoming requirement for Best Available Control Technology (BACT). A typical BACT determination for these glycol dehydration units is a condensation unit with 95% reduction of VOCs and HAPs. In the calculations presented herein, it is assumed that the glycol dehydration emissions from centralized facilities are reduced by 95%.

- The centralized facilities configuration eliminates flashing emissions.

Following separation at the well, the well gas and associated condensate are recombined and sent to the centralized facility. At the centralized facility, the well product is sent through a condensate stabilizer, which separates the light hydrocarbons (volatiles) from the heavy hydrocarbons (low-volatility liquids). The light hydrocarbons are compressed and introduced to the sales gas line. The heavy hydrocarbons are captured and become a salable liquid. Therefore, all emissions from flashing are eliminated.

In addition, because there will be no emissions from flashing under the CF mitigation measure, even the flares required as BACT for high productivity wells under the original scenario are no longer required.

I.2 Production Emissions for the 1/16 Centralized Facilities Configuration

As discussed in Section I.1, the overall production emissions decrease with centralized facilities as a result of the required operational modifications. A comparison of the total well field emissions from each scenario is shown in Table I.1, and the percentage decrease in annual emissions for each scenario is shown in Table I.2 and Figure I.1. As shown in this table, the annual emissions decrease as the percentage of wells operated by centralized facilities increases. Detailed calculations are included in Tables I.3 - I.5.

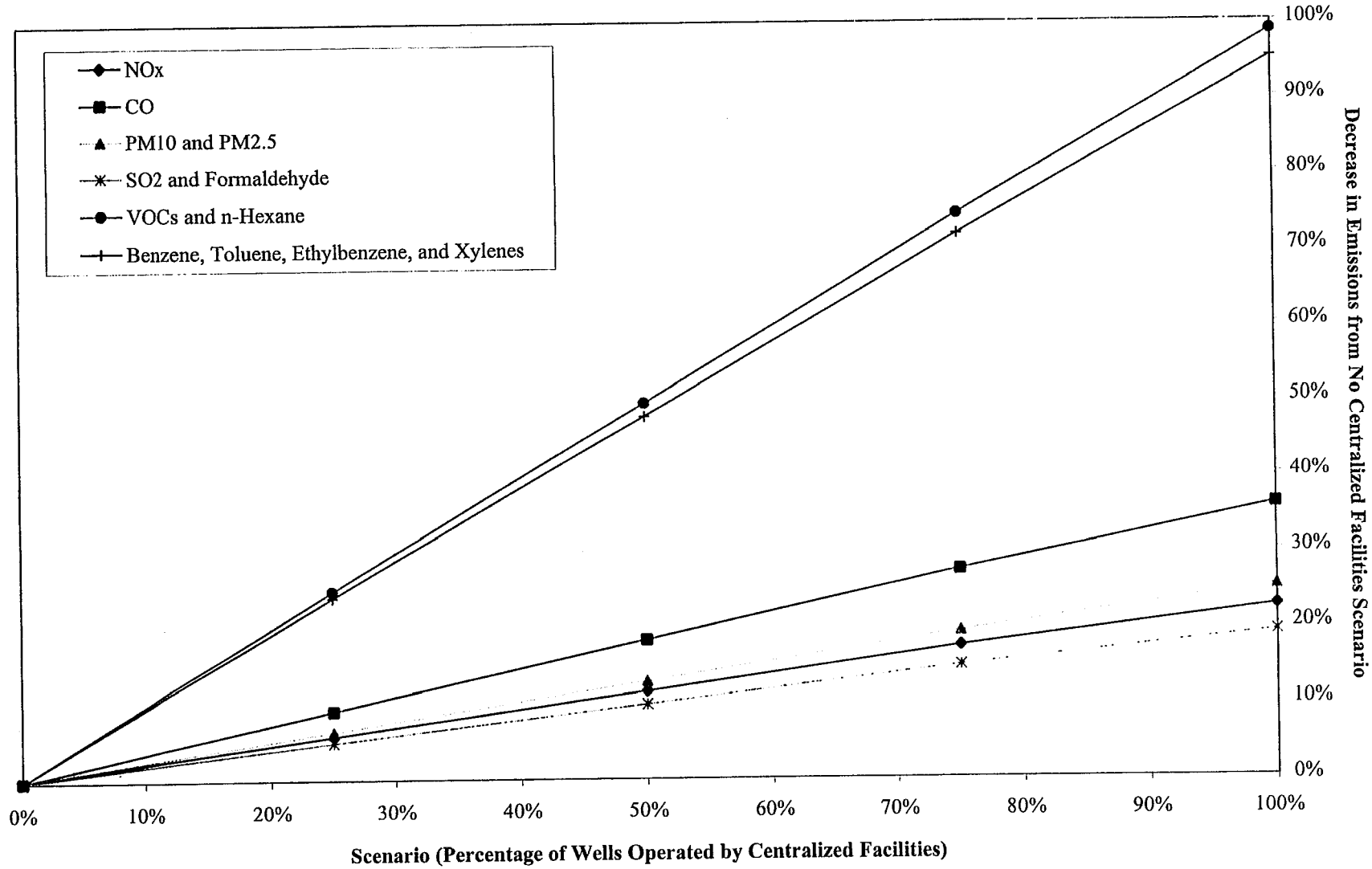
TABLE I.1
ANNUAL EMISSIONS (TONS/YEAR) FOR FIVE 1/16 CENTRALIZED FACILITIES SCENARIOS

Pollutant	Percentage of Wells Controlled by Centralized Facilities				
	0%	25%	50%	75%	100%
NO_x	44.8	42.2	39.6	37.0	34.7
CO	44.8	40.7	36.6	32.5	28.7
PM_{10}	3.5	3.3	3.1	2.9	2.6
$PM_{2.5}$	3.5	3.3	3.1	2.9	2.6
SO_2	0.3	0.3	0.2	0.2	0.2
VOCs	7,129.8	5,361.4	3,592.9	1,824.5	96.9
Benzene	239.5	182.2	124.9	67.6	11.7
Toluene	580.4	441.7	303.0	164.4	29.0
Ethylbenzene	39.7	30.2	20.7	11.2	1.9
Xylenes	495.5	377.1	258.7	140.3	24.8
n-Hexane	267.9	200.9	134.0	67.0	1.5
Formaldehyde	0.032	0.031	0.029	0.027	0.026

TABLE I.2
PERCENTAGE DECREASE IN ANNUAL EMISSIONS FROM THE NO CENTRALIZED FACILITIES SCENARIO

Pollutant	Percentage of Wells Controlled by Centralized Facilities				
	0%	25%	50%	75%	100%
NO_x	---	6%	12%	17%	22%
CO	---	9%	18%	27%	36%
PM_{10}	---	6%	13%	19%	25%
$PM_{2.5}$	---	6%	13%	19%	25%
SO_2	---	5%	10%	15%	19%
VOCs	---	25%	50%	74%	99%
Benzene	---	24%	48%	72%	95%
Toluene	---	24%	48%	72%	95%
Ethylbenzene	---	24%	48%	72%	95%
Xylenes	---	24%	48%	72%	95%
n-Hexane	---	25%	50%	75%	99%
Formaldehyde	---	5%	10%	15%	19%

Figure I.1
Emissions Reduction for 1/16 Centralized Facilities Scenario



I.3 Operational Modifications for the 1/8 Centralized Facilities Configuration

Another centralized facilities mitigation measure being considered for the PAP is one in which each centralized facility will control 8 wells instead of 16 wells. The operational changes discussed in Section I.1 will also be necessary for this configuration. However, this mitigation measure results in only a slight difference in emissions from those discussed in Section I.2. The only difference in emissions between the 1/ 8 configuration and the 1/16 configuration is the size of the glycol heater at the CF. Because the glycol heater contributes less than 2% of the total well field production emissions of each pollutant under the 1/16 scenario, changing the glycol heater size will result in only a small effect on the overall emissions. These emissions are not quantified herein, and for practical purposes are assumed to be equal to the emissions under the 1/16 configuration.

I.3. Production Emissions - No Centralized Facilities

A. Three-Phase Separator Heater (October - April only)[4]

Assumptions:

Size	0.75 MMBtu/hour	Jonah II EIS
Fuel heat content	1,000 Btu/SCF	Jonah II EIS
Time	5,088 hours/year	Jonah II EIS, October - April
	15 minutes/hr	

Pollutant	Emission Factors lb/MMCF		Emissions per Well lb/hr - max	tons/year
NOx	100.00	1	1.88E-02	4.77E-02
CO	84.00	1	1.58E-02	4.01E-02
VOCs	5.50	1	1.03E-03	2.62E-03
PM10	7.60	1	1.43E-03	3.63E-03
PM2.5	7.60	3	1.43E-03	3.63E-03
SO2	0.60	1,2	1.13E-04	2.86E-04
Hexane	1.80	1	3.38E-04	8.59E-04
Benzene	2.10E-03	1	3.94E-07	1.00E-06
Toluene	3.40E-03	1	6.38E-07	1.62E-06
Formaldehyde	7.50E-02	1	1.41E-05	3.58E-05

[1]AP-42, Tables 1.4-1 and 1.4-2.

[2]Assumes 2000 grains S/MMCF gas

[3] All particulate matter assumed to be $PM_{2.5}$

[4] Emissions from May - September will be zero.

B. Dehydration Heater

Assumptions:

Size	0.13 MMBtu/hour	Jonah II EIS
Fuel heat content	1,000 Btu/SCF	Jonah II EIS
Time	8,760 hours/year	Jonah II EIS
	15 minutes/hr	

Pollutant	Emission Factors lb/MMCF		Emissions per Well lb/hr - max	tons/year
NOx	94.00	1	2.94E-03	1.29E-02
CO	40.00	1	1.25E-03	5.48E-03
VOCs	5.50	1	1.72E-04	7.53E-04
PM10	7.60	1	2.38E-04	1.04E-03
PM2.5	7.60	3	2.38E-04	1.04E-03
SO2	0.60	1,2	1.88E-05	8.21E-05
Hexane	1.80	1	5.63E-05	2.46E-04
Benzene	2.10E-03	1	6.56E-08	2.87E-07
Toluene	3.40E-03	1	1.06E-07	4.65E-07
Formaldehyde	7.50E-02	1	2.34E-06	1.03E-05

[1]AP-42, Tables 1.4-1 and 1.4-2.

[2]Assumes 2000 grains S/MMCF gas

[3] All particulate matter assumed to be $PM_{2.5}$

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I.3. Production Emissions - No Centralized Facilities (cont'd)

C. Dehydration VOC Emissions - GLYCALC

Total field gas production rate: 350.0 MMCF/day — BLM, Bill McMahan, 3/99, represents maximum year

	Emission Factor[1] lb/MMCF	PAP Emissions lb/hr	PAP Emissions ton/yr
VOCs	29.73	433.50	1,898.72
Benzene	3.65	53.28	233.36
Toluene	9.09	132.49	580.32
Ethylbenzene	0.60	8.79	38.50
Xylenes	7.75	113.02	495.03
n-Hexane	0.28	4.13	18.11

[1]Emission factors developed from GLYCALC runs from McMurry Oil (3/99).

D. Flashing Emissions - HYSIM

Total field condensate production rate:	3,150 BBL/day	BLM, Bill McMahan, 3/99, represents maximum year
	0.11 MMCF gas/bbl condensate	BLM, Bill McMahan, 3/99
Pressure	700 psig	McMurry Oil, Robin Smith, 3/99
Flare efficiency	98%	*Oil and Gas Production Facilities: Section 21 Permitting Guidance*, WDEQ, AQD, 11/98.
Percentage of gas from wells with BACT	20%	Based on normal standard distribution and assumption that 20% of gas is produced through wells with BACT (700 well scenario)

	Emission Factor[1] lb/bbl	PAP Emissions w/BACT[2] lb/hr	PAP Emissions w/BACT[2] ton/yr	PAP Emissions w/o BACT[2] lb/hr	PAP Emissions w/o BACT[2] ton/yr	PAP Emissions Total lb/hr	PAP Emissions Total ton/yr
VOCs	11.31	5.94	26.01	1,188	5,203	1,194	5,229
Benzene	1.32E-02	0.01	0.03	1.38	6.06	1.39	6.09
Toluene	1.11E-04	5.8E-05	2.6E-04	1.2E-02	5.1E-02	1.2E-02	5.1E-02
Ethylbenzene	2.56E-03	1.3E-03	5.9E-03	2.7E-01	1.2E+00	2.7E-01	1.2E+00
Xylenes	9.45E-04	5.0E-04	2.2E-03	9.9E-02	4.3E-01	1.0E-01	4.4E-01
n-Hexane	5.39E-01	0.28	1.24	57	248	57	249

[1]Emission factors developed from HYSYS runs from McMurry Oil, 3/99.

[2]Assume 26% of condensate production is coming from wells with BACT.

I.3. Production Emissions - No Centralized Facilities (cont'd)

E. Flare on Flashing Vent

Average gas flared for wells with BACT:	302.74 scf/bbl	Jonah II EIS
	0.19 MMSCF/day	Assume 20% of condensate production is coming from wells with BACT.
Gas heat content	1000 Btu/scf	Jonah II EIS
Percentage of gas from wells with BACT	20%	Based on normal standard distribution and assumption that 20% of gas is produced through wells with BACT (700 well scenario)

Combustion Emissions - Flare

	Emission Factors	Volume of Gas Flared	
	lb/MMCF	lb/hr	tons/year
NO_x [1]	0.00	0.54	2.37
CO [1]	370.00	2.94	12.88
PM_{10} [2]	7.60	0.06	0.265
$PM_{2.5}$ [2]	7.60	0.06	0.265
SO_2	0.00	0.00	0.00

[1]AP-42, Tables 13.5-1 and 13.5-2, 9/91.

[2]AP-42, Tables 1.4-2 and 1.4-3 (3/98)

I.4. Production Emissions - Centralized Facilities

A. Three-Phase Separator Heater (October - April only)[4]

Assumptions:

Size	12.00 MMBtu/hour	Jonah II EIS
Fuel heat content	1,000 Btu/SCF	Jonah II EIS
Time	5,088 hours/year	Jonah II EIS, October - April
	15 minutes/hr	

Pollutant	Emission Factors lb/MMCF		Emissions per Centralized Facility lb/hr - max	tons/year
NOx	100.00	[1]	0.30	0.763
CO	84.00	[1]	0.25	0.641
VOCs	5.50	[1]	0.017	0.042
PM10	7.60	[1]	0.023	0.058
PM2.5	7.60	[3]	0.023	0.058
SO2	0.60	[1,2]	1.80E-03	0.005
Hexane	1.80	[1]	5.40E-03	0.014
Benzene	2.10E-03	[1]	6.30E-06	1.60E-05
Toluene	3.40E-03	[1]	1.02E-05	2.59E-05
Formaldehyde	7.50E-02	[1]	2.25E-04	5.72E-04

[1] AP-42, Tables 1.4-1 and 1.4-2.

[2] Assumes 2000 grains S/MMCF gas

[3] All particulate matter assumed to be $PM_{2.5}$

[4] Emissions from May - September will be zero.

B. Dehydration Heater

Assumptions:

Size	0.25 MMBtu/hour	Jonah II EIS
Fuel heat content	1,000 Btu/SCF	Jonah II EIS
Time	8,760 hours/year	Jonah II EIS
	15 minutes/hr	

Pollutant	Emission Factors lb/MMCF		Emissions per Centralized Facility lb/hr - max	tons/year
NOx	94.00	[1]	0.006	0.026
CO	40.00	[1]	0.003	0.011
VOCs	5.50	[1]	3.44E-04	0.002
PM10	7.60	[1]	4.75E-04	0.002
PM2.5	7.60	[3]	4.75E-04	0.002
SO2	0.60	[1,2]	3.75E-05	1.64E-04
Hexane	1.80	[1]	1.13E-04	4.93E-04
Benzene	2.10E-03	[1]	1.31E-07	5.75E-07
Toluene	3.40E-03	[1]	2.13E-07	9.31E-07
Formaldehyde	7.50E-02	[1]	4.69E-06	2.05E-05

[1] AP-42, Tables 1.4-1 and 1.4-2.

[2] Assumes 2000 grains S/MMCF gas

[3] All particulate matter assumed to be $PM_{2.5}$

I.4. Production Emissions - Centralized Facilities (cont'd)

C. Dehydration VOC Emissions - GLYCALC

Total field gas production rate: 350.0 MMCF/day — BLM, Bill McMahan, 3/99, represents maximum year

Condensation unit (BACT) control efficiency: 95% — WDEQ, Cynthia Madison, 9/30/99 e-mail

	Emission Factor[1]	PAP Wellfield Emissions			
		Uncontrolled		Controlled	
	lb/MMCF	lb/hr	ton/yr	lb/hr	ton/yr
VOCs	29.73	433.50	1,898.72	21.67	94.94
Benzene	3.65	53.28	233.36	2.66	11.67
Toluene	9.09	132.49	580.32	6.62	29.02
Ethylbenzene	0.60	8.79	38.50	0.44	1.93
Xylenes	7.75	113.02	495.03	5.65	24.75
n-Hexane	0.28	4.13	18.11	0.21	0.91

[1]Emission factors developed from GLYCALC runs from McMurry Oil (3/99).

D. Flashing Emissions - HYSIM

Total field condensate production rate: 0 BBL/day — BLM, Bill McMahan, 3/99, represents maximum year

0.11 MMCF gas/bbl condensate — BLM, Bill McMahan, 3/99

Pressure 700 psig — McMurry Oil, Robin Smith, 3/99

Flare efficiency 98% — Assumption

Percentage of gas from wells with BACT 20% — Based on normal standard distribution and assumption that 20% of gas is produced through wells with BACT (700 well scenario)

	Emission Factor[1]	PAP Wellfield Emissions					
		w/BACT[2]		w/o BACT[2]		Total	
	lb/bbl	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
VOCs	11.31	0.00	0.00	0.00	0.00	0.00	0.00
Benzene	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Toluene	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ethylbenzene	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Xylenes	0.00	0.00	0.00	0.00	0.00	0.00	0.00
n-Hexane	0.54	0.00	0.00	0.00	0.00	0.00	0.00

[1]Emission factors developed from HYSYS runs from McMurry Oil, 3/99.

[2]Assume 26% of condensate production is coming from wells with BACT.

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I.4. Production Emissions - Centralized Facilities (cont'd)

E. Flare on Flashing Vent

Average gas flared for wells with BACT:	0 scf/bbl	Jonah II EIS
	0.00 MMSCF/day	Assume 26% of condensate production is coming from wells with BACT.
Gas heat content	1000 Btu/scf	Jonah II EIS
Percentage of gas from wells with BACT	20%	Based on normal standard distribution and assumption that 20% of gas is produced through wells with BACT (700 well scenario)

Combustion Emissions - Flare

	Emission Factors	Volume of Gas Flared	
	lb/MMCF	lb/hr	tons/year
NO_x [1]	68.00	0.00	0.00
CO [1]	370.00	0.00	0.00
PM_{10} [2]	7.60	0.00	0.000
$PM_{2.5}$ [2]	7.60	0.00	0.000
SO_2	0.00	0.00	0.00

[1]AP-42, Tables 13.5-1 and 13.5-2, 9/91.

[2]AP-42, Tables 1.4-2 and 1.4-3 (3/98)

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I.5. Summary of Centralized Facilities Alternative

A. Summary - Well Field with 0% Centralized Facilities

700.00 wells
16 wells per centralized facility
0 centralized facilities
0% centralized facilities

	Wellfield Emissions	
	lb/hr	tons/year
NOx	15.72	44.76
CO	14.84	44.76
PM_{10}	1.22	3.53
$PM_{2.5}$	1.22	3.53
SO_2	0.09	0.26
VOCs	1,628.10	7,129.76
Benzene	54.67	239.45
Toluene	132.50	580.37
Ethylbenzene	9.06	39.68
Xylenes	113.12	495.47
n-Hexane	61.27	267.92
Formaldehyde	0.011	0.032

B. Summary - Well Field with 100% Centralized Facilities

700.00 wells
16 wells per centralized facility
44 centralized facilities
100% centralized facilities

	Wellfield Emissions		Annual Percentage Decrease from Base Case*
	lb/hr	tons/year	
NOx	13.46	34.71	22%
CO	11.20	28.69	36%
PM_{10}	1.02	2.64	25%
$PM_{2.5}$	1.02	2.64	25%
SO_2	0.08	0.21	19%
VOCs	22.42	96.85	99%
Benzene	2.66	11.67	95%
Toluene	6.63	29.02	95%
Ethylbenzene	0.44	1.93	95%
Xylenes	5.65	24.75	95%
n-Hexane	0.45	1.53	99%
Formaldehyde	0.010	0.026	19%

*Base case is the original case presented in the Air Emissions Inventory Technical Report, May 1999, with no centralized facilities (see Table I.5.A.)

I.5. Summary of Centralized Facilities Alternative (cont'd)

C. Summary - Well Field (25% Centralized Facilities)

700.00 wells
16 wells per centralized facility
11 centralized facilities
25% centralized facilities
524 non-centralized facilities

	Wellfield Emissions		Annual Percentage Decrease from Base Case*
	lb/hr	tons/year	
NOx	15.13	42.19	6%
CO	13.91	40.68	9%
PM_{10}	1.17	3.30	6%
$PM_{2.5}$	1.17	3.30	6%
SO_2	0.09	0.25	5%
VOCs	1,224.35	5,361.35	25%
Benzene	41.59	182.16	24%
Toluene	100.85	441.70	24%
Ethylbenzene	6.89	30.19	24%
Xylenes	86.09	377.08	24%
n-Hexane	45.98	200.94	25%
Formaldehyde	0.011	0.031	5%

*Base case is the original case presented in the Air Emissions Inventory Technical Report, May 1999, with no centralized facilities (see Table I.3.B.)

D. Summary - Well Field (50% Centralized Facilities)

700.00 wells
16 wells per centralized facility
22 centralized facilities
50% centralized facilities
348 non-centralized facilities

	Wellfield Emissions		Annual Percentage Decrease from Base Case*
	lb/hr	tons/year	
NOx	14.55	39.61	12%
CO	12.98	36.60	18%
PM_{10}	1.12	3.08	13%
$PM_{2.5}$	1.12	3.08	13%
SO_2	0.09	0.23	10%
VOCs	820.61	3,592.93	50%
Benzene	28.51	124.88	48%
Toluene	69.19	303.03	48%
Ethylbenzene	4.72	20.69	48%
Xylenes	59.06	258.69	48%
n-Hexane	30.68	133.96	50%
Formaldehyde	0.011	0.029	10%

*Base case is the original case presented in the Air Emissions Inventory Technical Report, May 1999, with no centralized facilities (see Table I.3.B.)

I.5. Summary of Centralized Facilities Alternative (cont'd)

E. Summary - Well Field (75% Centralized Facilities)

700.00 wells
16 wells per centralized facility
33 centralized facilities
75% centralized facilities
172 non-centralized facilities

	Wellfield Emissions		Annual Percentage Decrease
	lb/hr	tons/year	from Base Case*
NOx	13.96	37.03	17%
CO	12.04	32.52	27%
PM_{10}	1.07	2.85	19%
$PM_{2.5}$	1.07	2.85	19%
SO_2	0.08	0.22	15%
VOCs	416.86	1,824.52	74%
Benzene	15.43	67.59	72%
Toluene	37.53	164.37	72%
Ethylbenzene	2.56	11.19	72%
Xylenes	32.03	140.31	72%
n-Hexane	15.39	66.98	75%
Formaldehyde	0.010	0.027	15%

*Base case is the original case presented in the Air Emissions Inventory Technical Report, May 1999, with no centralized facilities (see Table I.3.B.)